from a recording medium, image elements expressing data elements are detected from the read image data to obtain a two-dimensional data matrix, and an error on the matrix is corrected according to error checking codes included in this matrix, thereby reproducing target data. Thus, target data can be correctly reproduced even if an error occurs on a two-dimensional data matrix when an encoded image is read, when image elements are recognized from the image data, or due to error factors before these processes.

Since a means for changing the order of a data matrix with error checking codes in recording and for reversing the order to restore the original data matrix with the error checking codes in reproduction is arranged, characteristics strong against burst errors can be obtained. More specifically, even when errors continuously occur in recognition of image elements during reproduction due to a considerably large contamination on an encoded image on a recording medium, the burst errors can be converted to discrete errors on the original data matrix with the error checking codes. Therefore, these errors can be easily corrected within the error correction capability of the error checking codes. As a result, reproducibility of correct target data can be improved.

Furthermore, according to one arrangement of the present invention, a read error of image elements of an encoded image caused by a change in conversion characteristics of an image sensor, especially, a change in characteristics caused by DC components, i.e., continuation of the same density is taken into consideration. When an encoded image is recorded, element values of a data matrix constituting given data ar randomized using pseudo random numbers. Upon reproduction, after the randomized data matrix is obtained, the data matrix is derandomized to restore element values of the original data matrix. Therefore, no long mesh arrays having the same density appear in the encoded image on the recording medium. When the encoded image is read, pixels can be accurately digitized (e.g., binarized), and an error in reproduced data caused by a read error can be prevented.

Some embodiments of the present invention have been described. However, these embodiments are merely examples, and the present invention may have various other arrangements. All the modifications and applications of the present invention are incorporated in the scope of the invention, and, hence, the scope of the present invention should be determined by only the appended claims and their equivalents.

What is claimed is:

1. A data reading method of reading data encoded as an image recorded on a recording medium, comprising the steps of:

(A) reading image data representing an image from the recording medium on which the image is recorded, said image being constituted by (i) a mesh pattern including a plurality of black and white meshes arrayed in a matrix, said mesh pattern being obtained by encoding data, and (ii) a main scanning reference pattern for indicating a data sampling reference in a main scanning direction of the mesh pattern;

(B) dividing the read image data into a plurality of partial image data segments;

(C) searching feature pixel groups featuring pieces of the main scanning reference pattern from the partial image data segments, said feature pixel groups lying within the partial image data segments;

(D) determining positions of pieces of the main scanning reference pattern in the partial image data segments from which the feature pixel groups are not detected in said searching step by executing an interpolation process on the basis of positions of pieces of the main scanning reference pattern which have been detected in the searching step for other partial image data segments, thereby generating position data of the pieces of the main scanning reference pattern on the image data; and

(E) identifying black and white levels of meshes of the mesh pattern by detecting levels of the image data at positions designated on the basis of the generated position data.

2. A data reading apparatus for reading data encoded as an image recorded on a recording medium, comprising:

(A) image sensor means for reading image data representing an image from the recording medium on which an image is recorded, said image being constituted by (i) a mesh pattern including a plurality of black and white meshes arrayed in a matrix, said mesh pattern being obtained by encoding data, and (ii) a main scanning reference pattern for indicating a data sampling reference in a main scanning direction of the mesh pattern;

(B) segmentation means for dividing read image data into a plurality of partial image data segments;

(C) main scanning reference pattern searching means for searching feature pixel groups featuring pieces of the main scanning reference pattern from the partial image data segments, said feature pixel groups lying within the partial image data segments;

(D) main scanning reference pattern position generating means for determining positions of pieces of the main scanning reference pattern in the partial image data segments from which the feature pixel groups are not detected by said main scanning reference pattern searching means by executing an interpolation process on the basis of positions of pieces of the main scanning reference pattern which have been detected from other partial image data segments by said main scanning reference pattern searching means, thereby generating position data of the pieces of the main scanning reference pattern on the image data; and

(E) identification means for identifying black and white levels of meshes of the mesh pattern by detecting levels of the image data at positions designated on the basis of the generated positions data.

3. An apparatus according to claim **2**, wherein:

said main scanning reference pattern of said recording medium comprises two guide lines extending on two sides of said mesh pattern; and

said main scanning reference pattern searching means includes means for searching three white, black, and white run lengths having predetermined intervals and extending along a depth direction perpendicular to said main scanning direction of said image data as said feature pixel groups featuring pieces of image data of said guide lines.

4. A data reading method of reading data encoded as an image recorded on a recording medium, comprising the steps of:

(A) reading image data representing an image from the recording medium on which the image is recorded, said image being constituted by (i) a mesh